



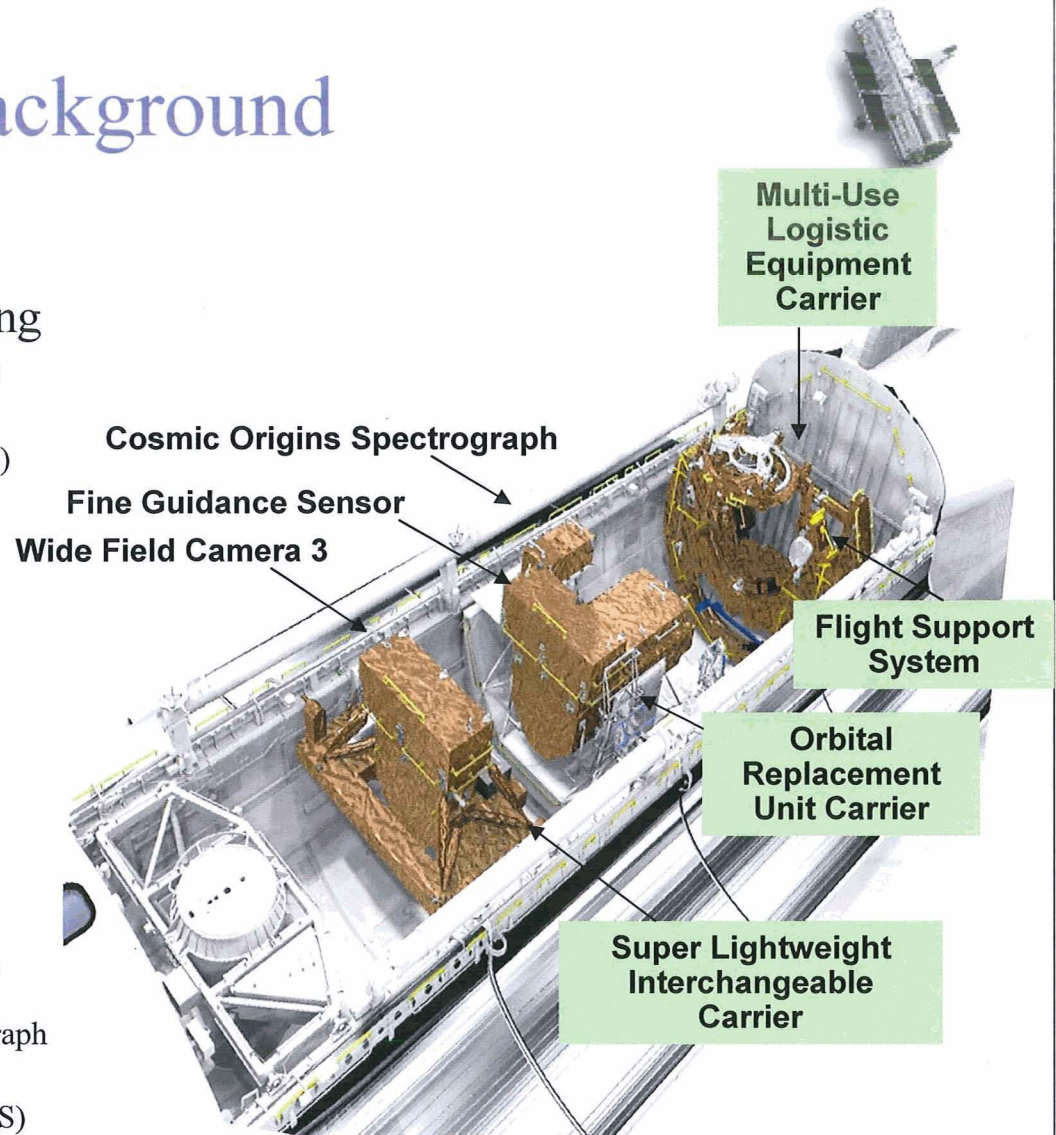
# Practical Cleanroom Operations Constraints

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# Background

- Hubble Space Telescope Servicing
  - Contamination sensitive instruments
    - Wide Field Camera 3 (WFC3)
    - Cosmic Origins Spectrograph (COS)
    - Fine Guidance Sensor (FGS)
  - Large space support equipment (carriers)
    - Flight Support System (FSS)
    - Orbital Replacement Unit Carrier (ORUC)
    - Super Lightweight Interchangeable Carrier (SLIC)
    - Multi-Use Lightweight Equipment (MULE)
  - Miscellaneous refurbishment items
    - Batteries, Rate Sensor Units (RSU), New Outer Blanket Layer (NOBL)
    - Space Telescope Imaging Spectrograph (STIS) repair
    - Advanced Camera for Surveys (ACS) repair





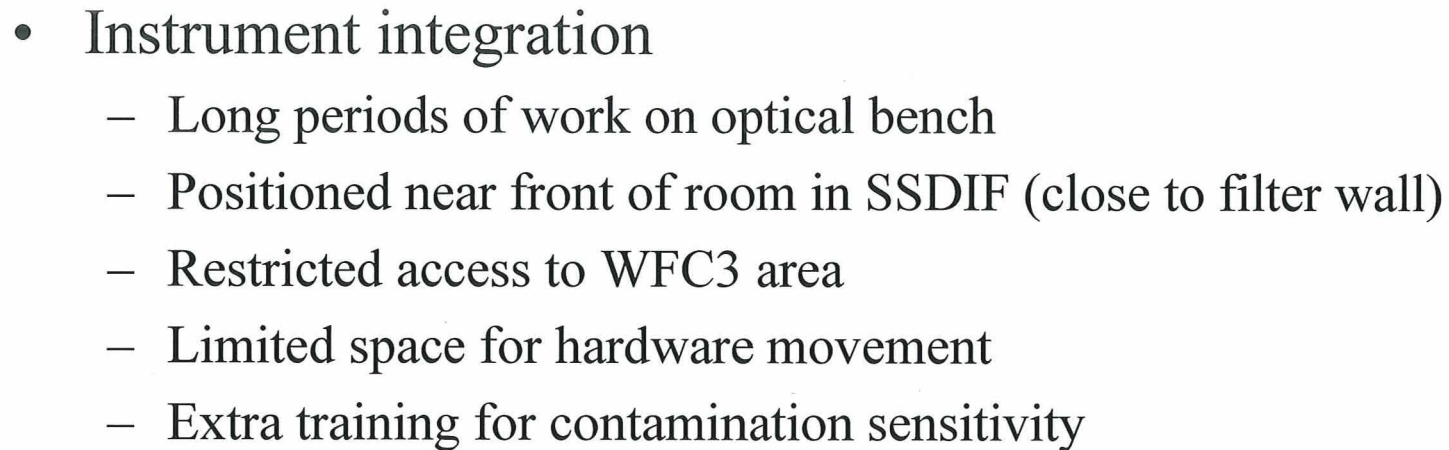


# GSFC Cleanroom Facility



- Spacecraft Systems Development and Integration Facility (SSDIF)
  - 90 feet wide by 120 feet long
  - Horizontal unidirectional flow cleanroom
  - Additional Features:
    - Access cleanroom via 25'x40' overhead rollup door
    - Two 35 ton cranes with heights of 69' and 80'
    - Precision Cleaning Facility
    - Hardware Storage Area

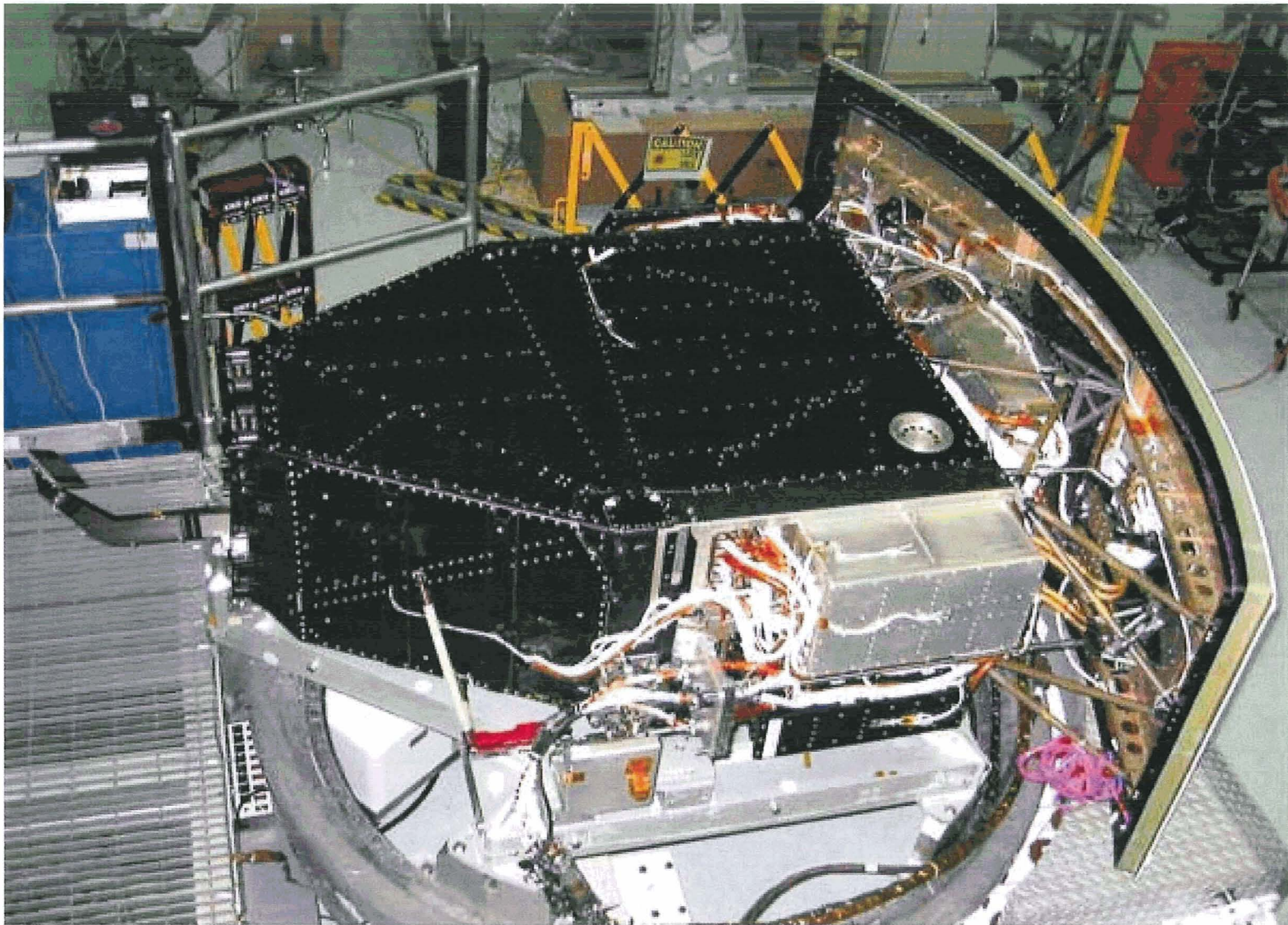








# WFC3 During Integration





# Operational Constraints



- Why constrain cleanroom activities?
  - Particle counts increase
  - Potential for reactive molecular contaminants
    - During bonding activities
  - Turbulent flow around hardware
    - Transport particles “upstream”
  - Potential for anomalies
    - Crane
      - Light fixture impact
    - Power failure
      - Lift Operations
      - Rollup door
    - High Humidity
    - Water Leak
    - Fire



## Constraint Table



- Created for consistency within Contamination Control Team
- Presented during “Refresher” Training for entire project
  - Overview only
  - Constraints added to work orders by CC team
- I&T manager requested a written copy





# Table



Restricted Activity	Open (Optics or Optical Bench Exposed)	Closed (Draped) (Enclosure Exposed, Aperture/Optics Covered)	Bagged (Instrument may be draped and taped)
Bonding / Staking / Lubricating	<b>Prohibited</b> within 10' < 6 g within 30'	< 6 g within 10' < 60 g within 30'	< 30 g within 10' Quantity within reason
Sanding / Abrading / Drilling (Vacuum pickup of debris during generation)	<b>Prohibited</b> upstream > 6 feet away for man-sized objects >20 feet away for larger objects	<b>Prohibited</b> upstream > 6 feet away for man-sized objects >20 feet away for larger objects	No Constraints
Crane Operations	<b>Prohibited</b>	<b>Prohibited</b>	No Constraint
SSDIF Maintenance	<b>Prohibited</b>	>20 feet downstream	No Constraint
Large Structure Cleaning	<b>Prohibited</b>	<b>Prohibited</b> upstream >20 feet away for man-sized objects >40 feet away for larger objects	No Constraint
Large Structure Unbagging	<b>Prohibited</b> Upstream > 30 feet away for man-sized objects larger objects <b>prohibited</b>	<b>Prohibited</b> upstream >20 feet away for man-sized objects >40 feet away for larger objects	No Constraint
Hardware Movement	<b>Prohibited</b> Upstream > 30 feet away for man-sized objects larger objects <b>prohibited</b>	<b>Prohibited</b> Upstream > 6 feet away for man-sized objects >20 feet away for larger objects	No Constraint
Personnel Activity	< 5 within 10' (SSDIF Max: 10)	< 10 within 10' (SSDIF Max: 40)	No Constraint (SSDIF Max: 40)
Air Bearing Use (Allow 30 minutes of settle time after use)	<b>Prohibited</b>	>30 feet downstream	No Constraint
Door Opening (Allow 30 minutes of settle time after door closing)	<b>Prohibited</b>	<b>Prohibited</b>	No Constraint





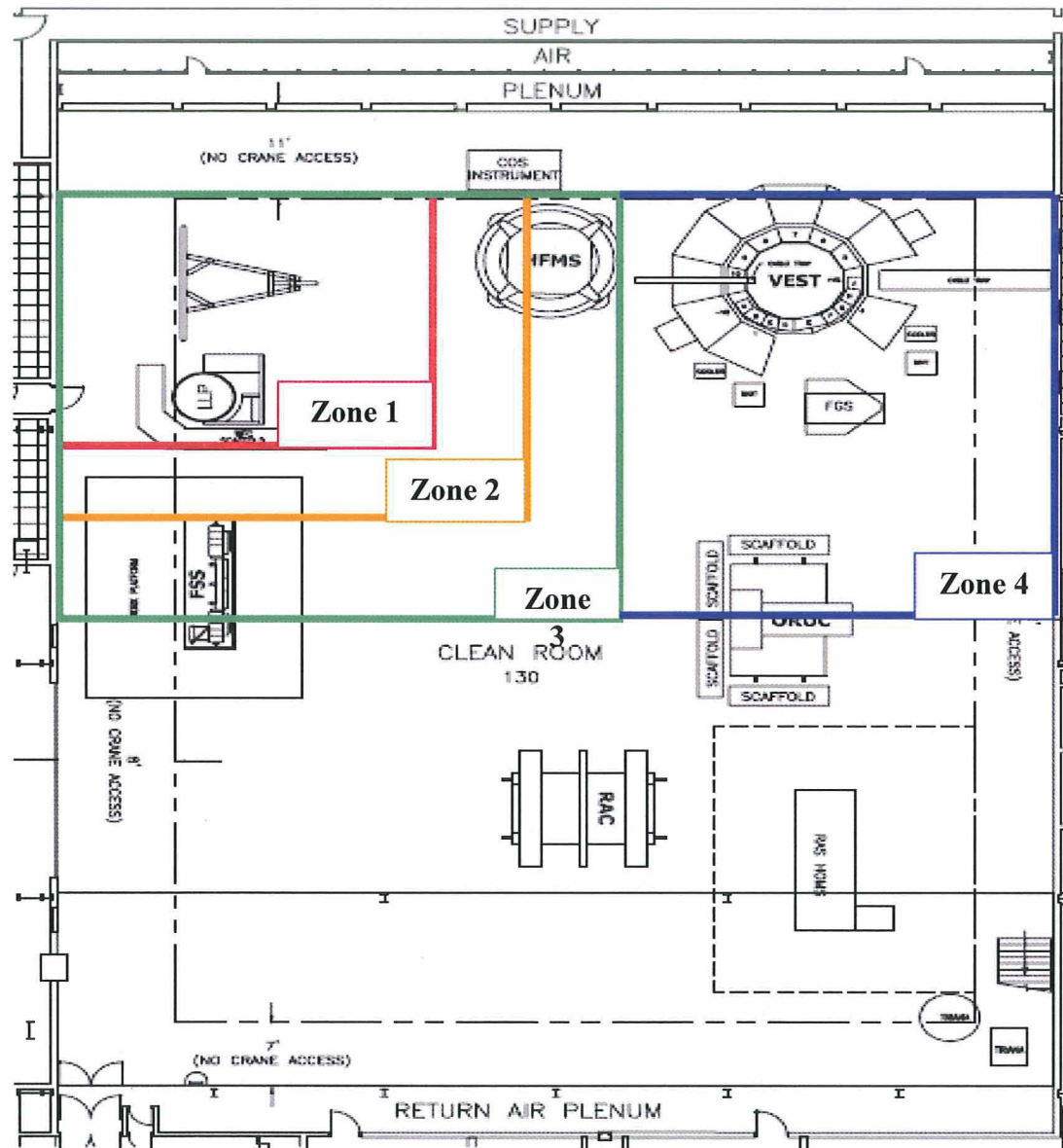
# Revisions



- Changed column definitions
  - Confusion between open, closed, draped and bagged
  - Defined draped
    - Cover entire instrument with sufficient material to hang along sides
  - Defined bagged
    - Llumalloy taped and fitted tightly enclosing entire instrument
- Personnel Limits
  - Contamination sensitive I&T operations for hardware besides WFC3
- Waive Constraints: Case by Case
  - Unplanned operations
  - Slight changes in Instrument Configuration
    - Mostly bagged with small openings
  - Special Visits: Astronaut Training, News Press, Tours



# SSDIF Layout





## More Confusion



- COS instrument
  - Moved to back of room for optical testing
  - Fixed zones did not account for move
- HFMS
  - Directly on boundary of zones
  - Approved use of man-lift work





## Activities Allowed Under Given WFC3 Condition and Activity Location



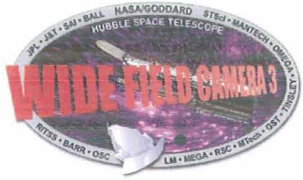
Condition:	WFC3 Unbagged (Loose Drape)					WFC3 Bagged (Drape and Tape)				
Zone	1	2	3	4	5	1	2	3	4	5
Bonding / Staking / Lubricating	<6g	<30g	<60g	<60g	<60g	<30g	OK	OK	OK	OK
Sanding/Abrading/Drilling	Down stream	<6' above floor	<6' above floor	OK	OK	OK	OK	OK	OK	OK
Crane Operations	WFC3 only	Prohibit	Prohibit	Prohibit	OK	OK	OK	OK	OK	OK
Air Bearing Use (Allow 30 minutes of settle time after use)	Prohibit	Prohibit	Prohibit	Down stream	OK	OK	OK	OK	OK	OK
Insert/Remove Bolts	<6' above floor	<6' above floor	Down stream	OK	OK	OK	OK	OK	OK	OK
Door Opening (Allow 30 minutes of settle after door closing)	<6' high	<6' high	<6' high	<6' high	<6' high	OK	OK	OK	OK	OK



# SSDIF Restrictions



- SSDIF restrictions of activities are driven by condition of Science Instruments (SI)
  - Unbagged, Draped, Bagged
- 3 Major Categories of SSDIF Activities
  - Relocation of Hardware
    - Lifts, Air Bearings, Door Openings
  - Hardware Activity
    - Painting, sanding, drilling, bonding, staking, soldering
  - Contamination Control Operations
    - Maintenance, Cleaning, Hardware Bagging/Unbagging
- Types of Restrictions
  - Personnel Limits: <15 SI Unbagged, 40 max
  - Time limits before opening SI: 30 min.
  - Distance away from SI: <6 ft. from ground, >10 ft. away from SI
  - Quantity of material: <30g of staking material



# Decision Tree

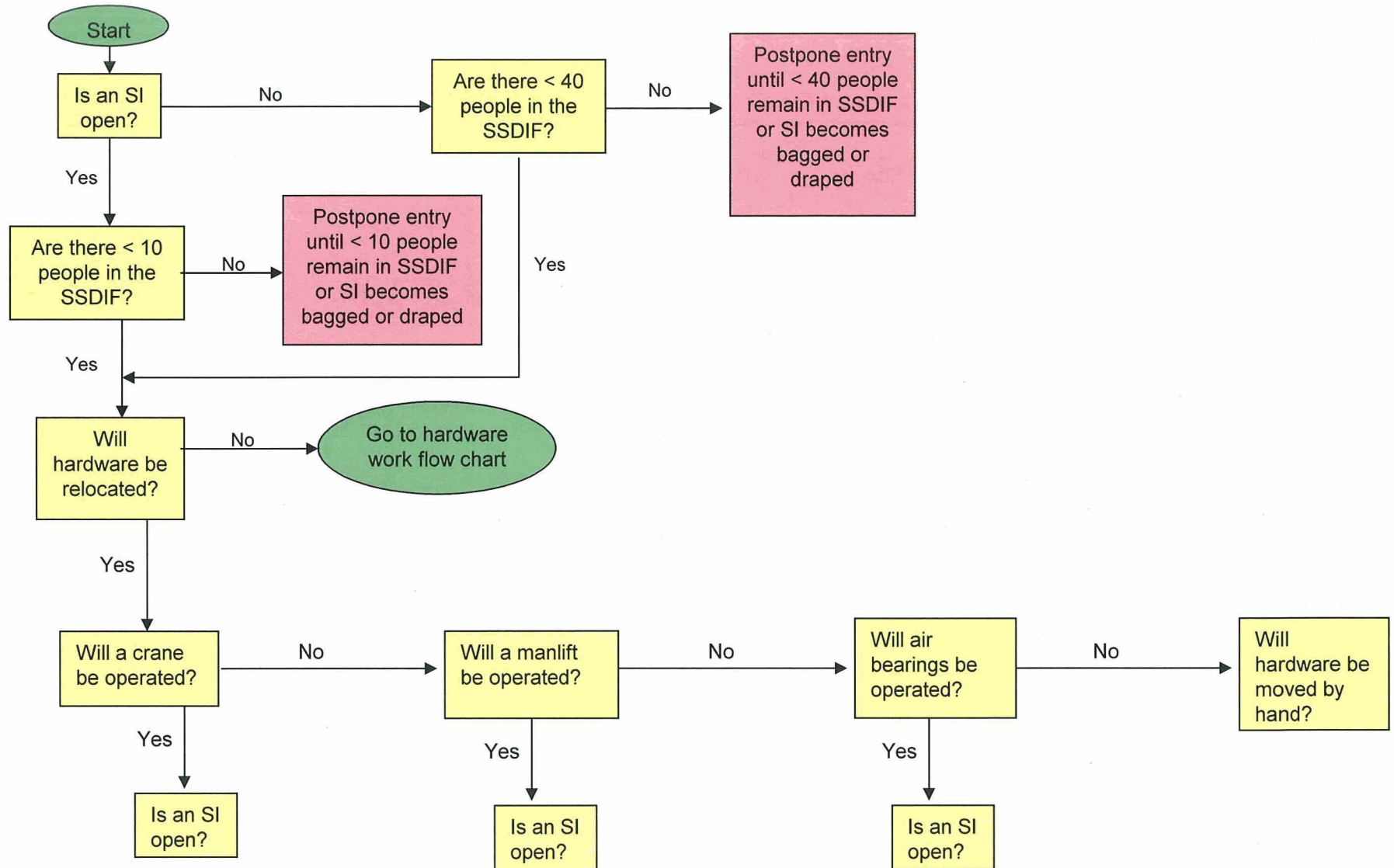


- Switched to decision tree
  - 3 Main Categories for Constraints
    - Hardware Relocation
    - Hardware Work
    - Contamination Operation
  - User Friendly
    - Answers most often asked questions
  - Provides additional new response: Call CCE
- Designed tree to support independent planning assessment by I&T manager
  - Many activities are easy to identify as ok or not ok
  - The remainder end in a “Call CCE” decision
  - Retained final authority at daily I&T meeting



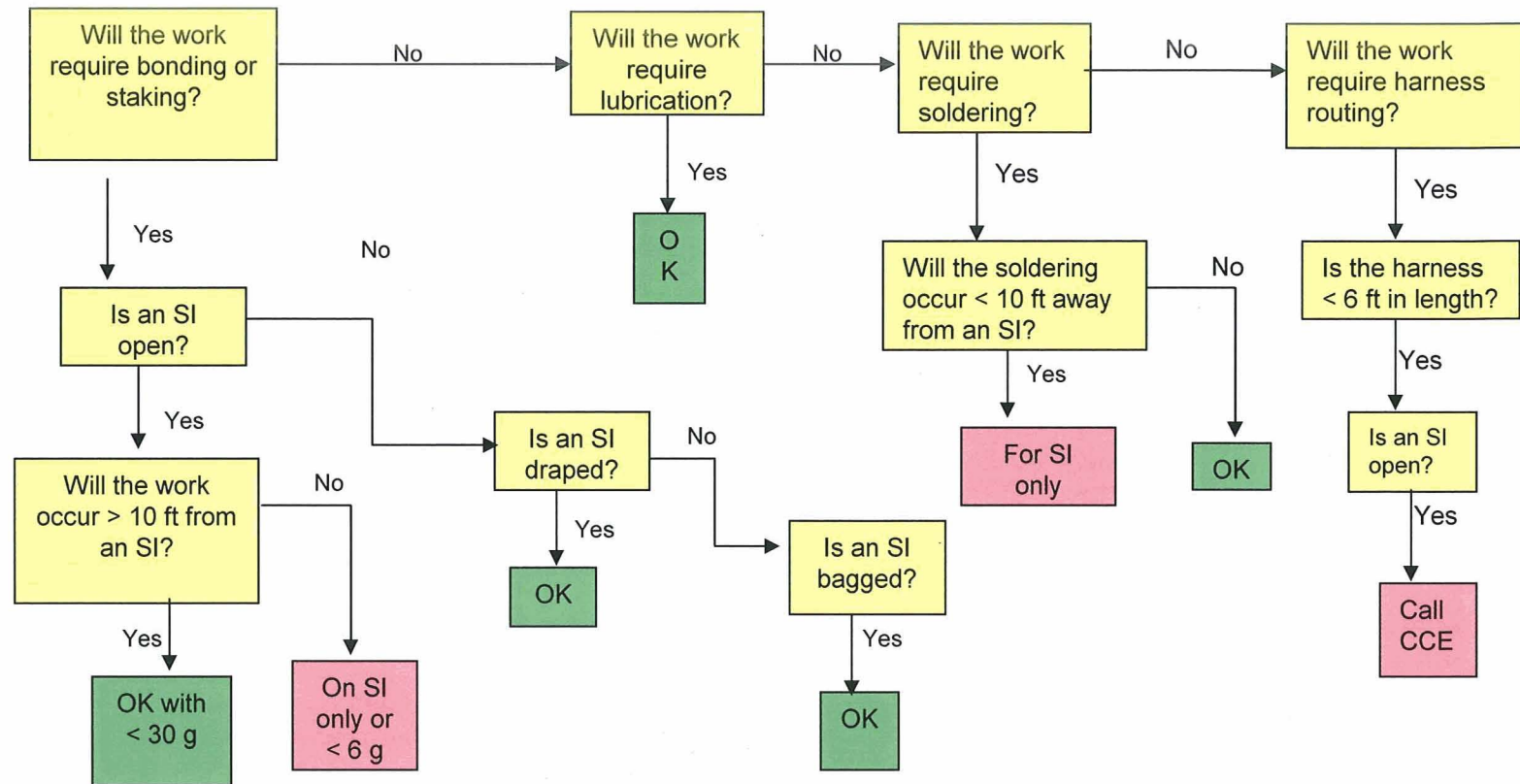


# Decision Tree – Hardware Relocation



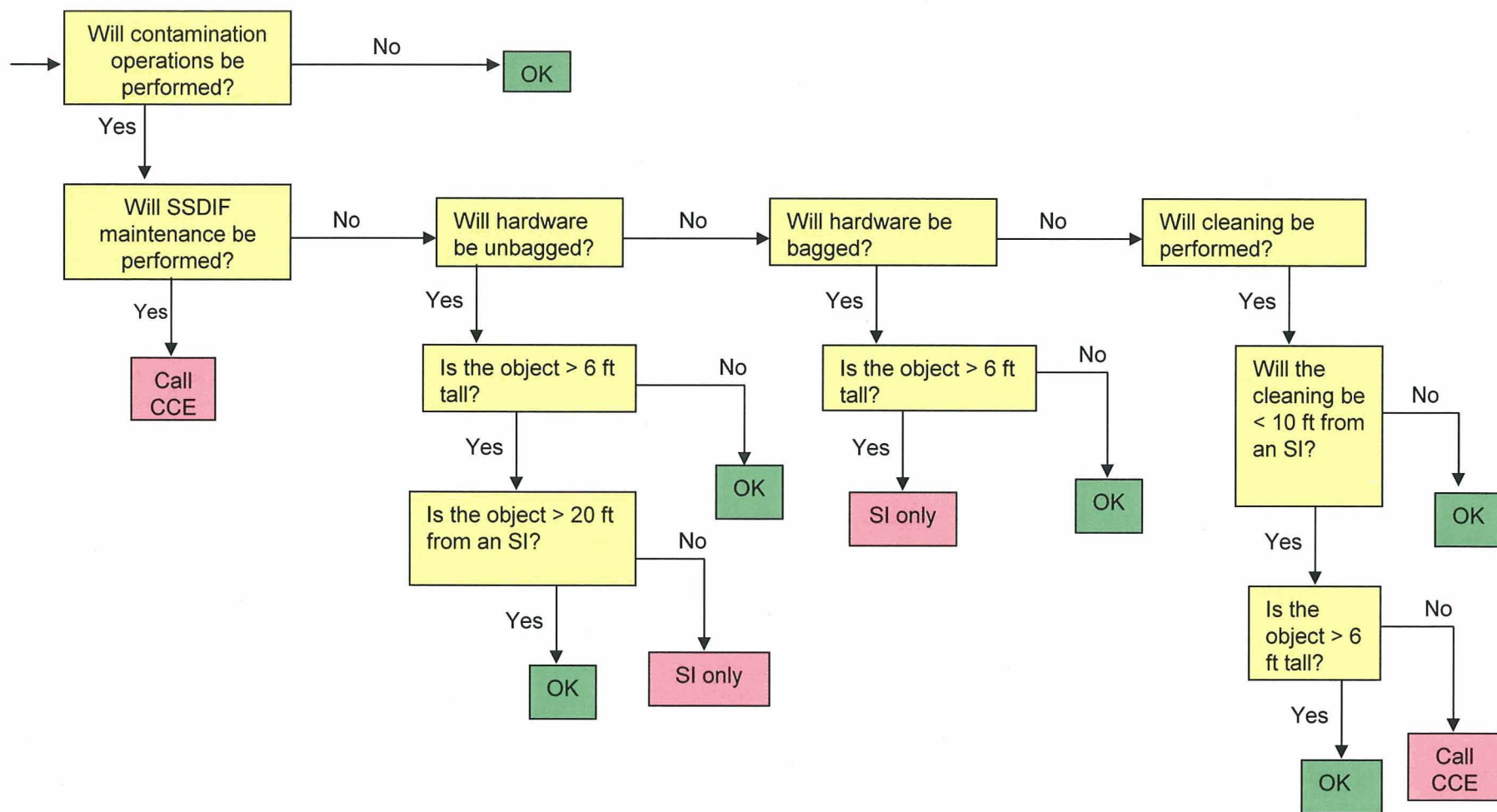


# Decision Tree - Hardware Work



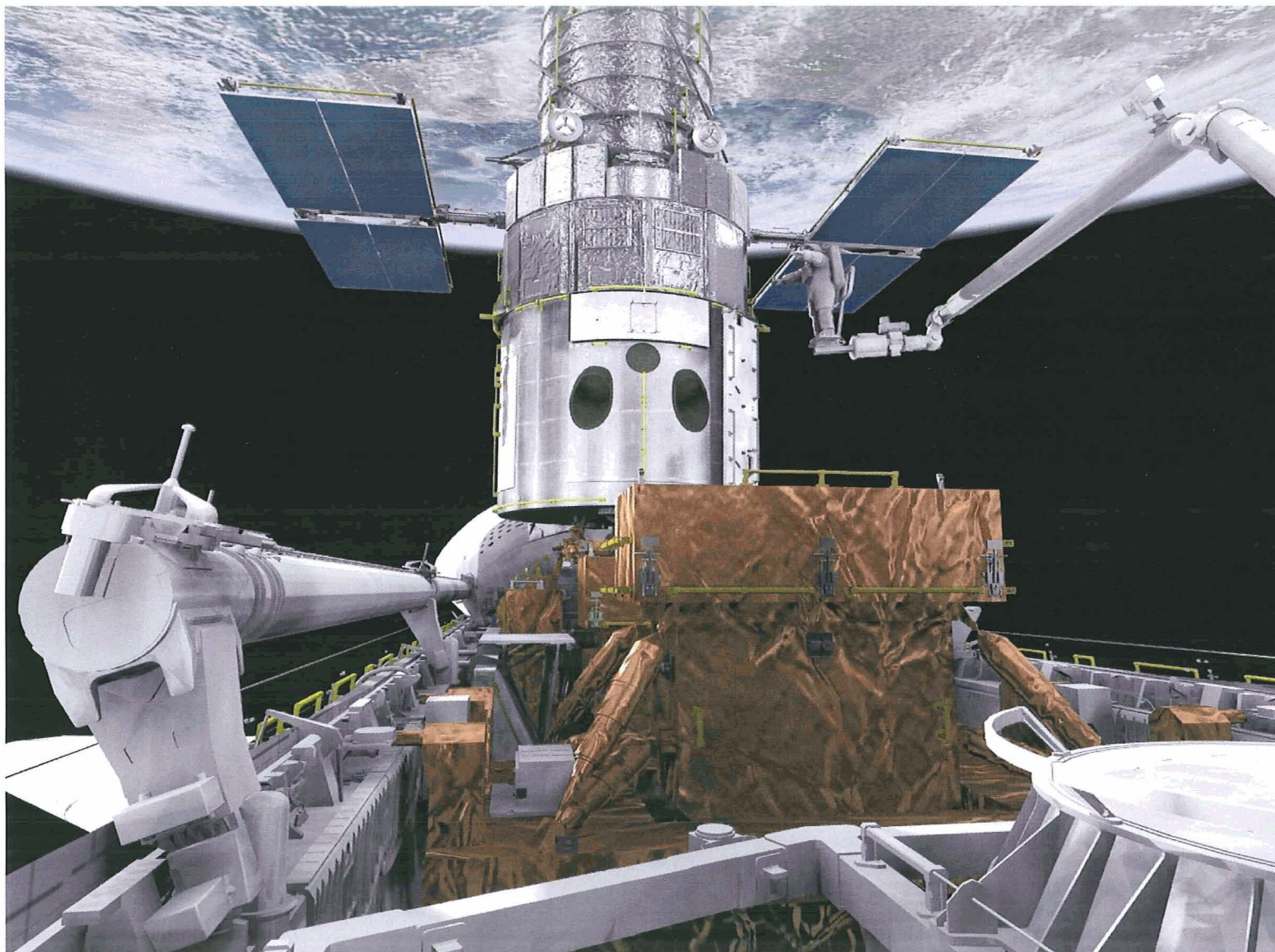


# Decision Tree Contamination Control Operations









2007 Contamination & Coatings Engineering Workshop